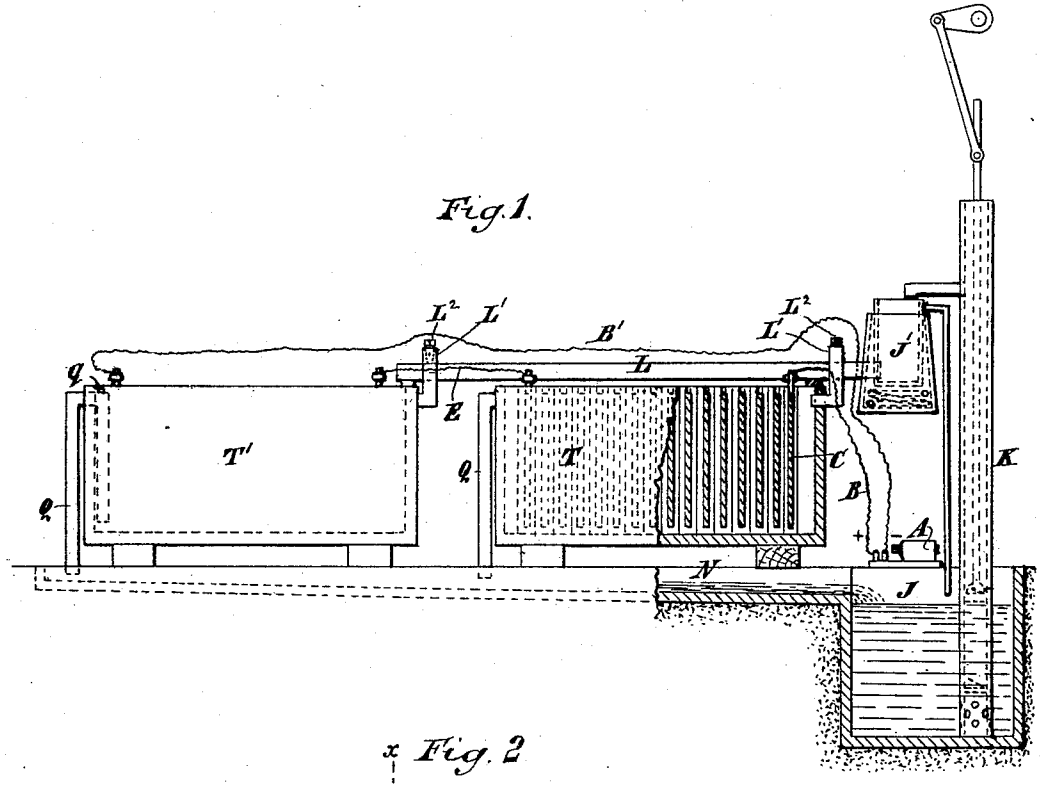
(No Model.) 2 Sheets—Sheet 1.

E. S. HAYDEN.

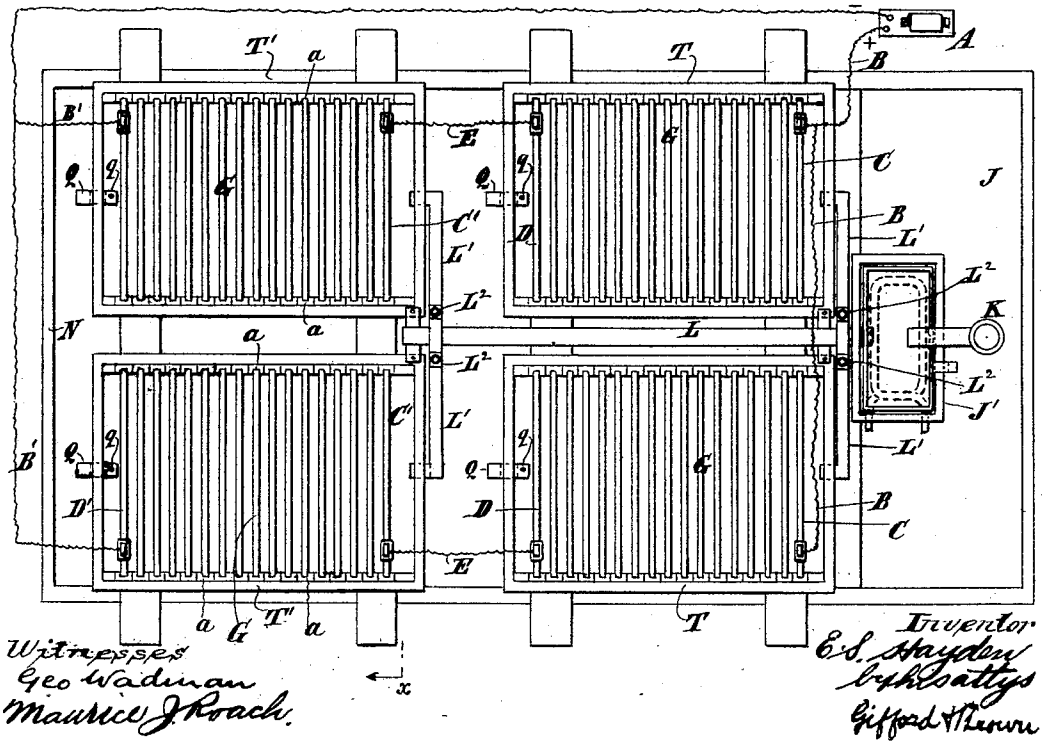
PROCESS OF ELECTROLYZING COPPER.

No. 377,487. Patented Feb. 7, 1888.

Fig. 1.



x Fig. 2



Witnesses
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(No Model.) 2 Sheets—Sheet 2.

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PROCESS OF ELECTROLYZING COPPER.

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Fig. 3.

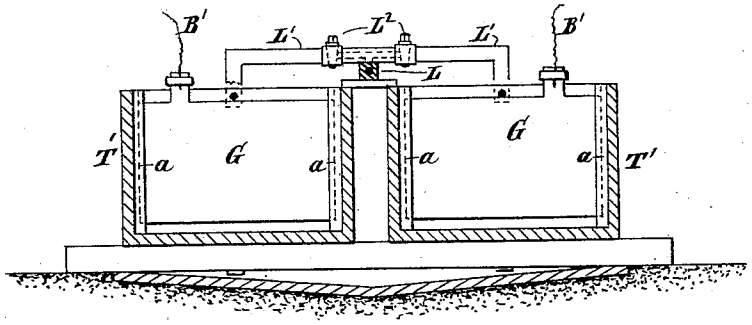


Fig. 4.

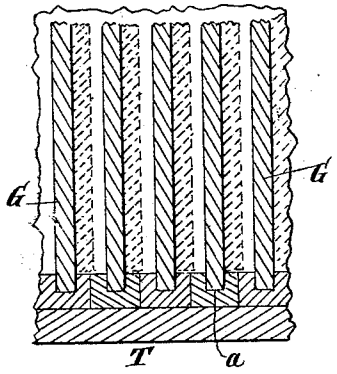
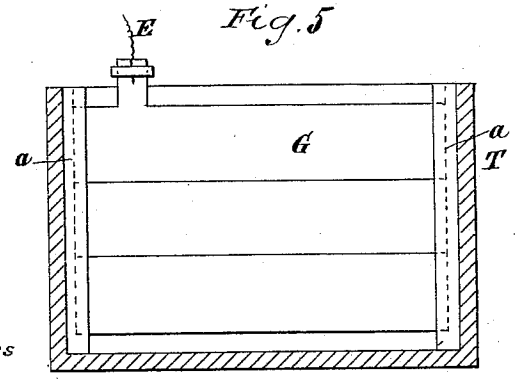


Fig. 6.



Fig. 5.



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UNITED STATES PATENT OFFICE.

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PROCESS OF ELECTROLYZING COPPER.

SPECIFICATION forming part of Letters Patent No. 377,487, dated February 7, 1888.

Application filed March 26, 1887. Serial No. 232,461. (No model.)

To all whom it may concern:

Be it known that I, EDWARD S. HAYDEN, of Waterbury, in the county of New Haven and State of Connecticut, have invented a certain new and useful Improvement in Treating Metal, of which the following is a specification.

The object of this improvement is to facilitate the separation of precious metals from baser metals, and also to separate from metals generally such foreign matters as may be incorporated with them. The improvement involves the treatment by electrolysis.

I will describe my improvement in detail, and then point out the various novel features in claims.

The accompanying drawings illustrate an apparatus adapted for use in carrying out my improvement.

Figure 1 is a sectional side view of electrolytic baths or tanks embodying my improvement, arranged in series, and a dynamo-electric machine connected therewith, together with certain appurtenances of the baths. Fig. 2 is a plan or top view of the same. Fig. 3 is a transverse vertical section of the apparatus, taken at the plane of the dotted line *x x*, Fig. 2, and looking in the direction indicated by the arrows extending from the ends of said dotted line. Fig. 4 is a horizontal section of a part of one of the baths which form parts of the apparatus. Fig. 5 is a transverse vertical section of one of the baths which form parts of the apparatus. Fig. 6 is a perspective view of one of a number of side pieces which are employed in each of the baths of the apparatus, for the purpose of receiving the side edges of the plates to be treated and supporting such plates above the bottom of the bath.

Similar letters of reference designate corresponding parts in all the figures.

A designates a dynamo-electric machine, which may be of any approved style suitable for electroplating. I have deemed it sufficient to give but an arbitrary representation of this machine; but I have marked the wires connected to the machine + and —, so that the representation will be perfectly intelligible. The positive pole is connected by a wire, B, with the anode-plates C of electrolytic baths or tanks T. I have shown two of these baths T arranged side by side, and have represented the wire B as branching, so as to extend to the anode-plates C of both of these baths. The cathode-plates D of these baths are connected by wires or rods E with the anode-plates C′ of other electrolytic baths or tanks, T′. There are two of the baths T′, and they are shown as arranged side by side and in line with the baths T.

There may be a different number of baths used; but I have illustrated a sufficient number to enable me to explain all that will be necessary for an understanding of my improvement. Should a greater number be used, they may be connected to the baths T′ in the same manner that the baths T′ are connected to the baths T. The last baths of the series, in the present instance the baths T′, have their cathode-plates D connected to a wire, B, which extends to the negative pole of the dynamo-electric machine.

The anode and cathode plates of each bath are arranged as far apart as possible, and consequently close to the ends of the bath. Between them are arranged a number of plates, G, of the metal which is to be treated for the purpose of refining it or separating its constituent parts. The anode-plate of each bath will generally be of the same character as the plates G of the metal to be treated. Assuming that the anode-plate of each bath is of copper combined with a greater or less percentage of precious metals and other foreign matter, and that the plates G to be treated are the same, the solution in the bath will be a copper solution—as, for instance, a sulphate-of-copper solution. The cathode-plates may then be made of any suitable material. Indeed, they may also be of copper. The plates of the metal to be treated may be cast in shape to be used in the baths; but it will be preferable to subject the plates of metal which are to be treated according to my improvement to a rolling operation for the purpose of compacting them and rendering them homogeneous. The rolling will be done before they are placed in the baths. They will be arranged as close together in the baths as they can be located without danger of contact, and supported so as to be elevated slightly above the bottom of the baths. The means whereby they are supported in the present example of my improvement consist of grooves *a* in the side pieces of the baths, such grooves being closed at the bottom so that they may not only sustain the plates sidewise, but vertically, by extending under the bottom of the lateral edge portions. When the plates are supported in this manner, their

main portions, which extend across the baths between the grooves *a*, and which are subject to electrolytic action, will not rest upon anything beneath them. The grooves *a* may be made in strips of wood which are independent of or made separate from the side walls of the baths.

It may be advantageous in many cases to form the plates to be treated in such sizes that several superposed one above the other will be required to extend from the lower portion to the upper portion of the baths. Then, if the grooved strips by which they are to be supported in the baths are adapted to fit tightly upon them, such strips may be the means of uniting a set of the small plates into one compound plate, as shown in Fig. 5.

It will be advantageous to soak the strips with paraffine if they shall be made of wood. In any case, the strips are to be made of non-conducting material.

The electrical current from the dynamo-electric machine passes to the anode-plates of the electrolytic baths T, and flows thence through the solution to the nearest of the plates G of metal to be treated. It flows thence in the same manner from one to another of the plates G, and ultimately to the cathode-plates of the baths. From the cathode-plates it proceeds to the anode-plates of the baths T′, and after passing through these baths in the same manner as it passed through the baths T it returns along the wire B′ to the dynamo-electric machine.

J designates a receptacle or reservoir which contains a supply of the electrolytic solution.

K designates a pump, which is employed to cause the flow of the electrolytic solution through the baths T T′ and to effect the mixing of the solution, in order that it may be maintained as far as practicable in a homogeneous condition. This pump causes the solution to flow from the reservoir J through the baths. After flowing through the latter it will return to the reservoir.

I do not desire to claim, broadly, the idea of circulating a solution through an electrolytic bath or baths, nor do I wish to be confined to any specific manner of effecting such circulation. The means whereby the solution may be circulated through the baths satisfactorily to me in carrying out my improvement I have illustrated in the drawings, and will now describe.

L designates a main supply-pipe leading from a tank, J′, with which the delivery-pipe of the pump is connected, and which consequently receives the solution that is conveyed by the pump from the reservoir J. This pipe L extends adjacent to the several baths, so that it may deliver solution into them.

I may provide any desirable means for effecting the heating of the solution. I have shown the tank J′ as having combined with it a compartment outside of that compartment or portion which receives the solution, and in such extra compartment I may arrange a steam-coil or otherwise circulate steam, so as to accomplish the desired result.

From the main supply-pipe L branch pipes L′ extend. They communicate with the baths near the top of the latter and have combined with them cocks L^2, in order that provision may be afforded for controlling the flow of the solution through them into the baths.

The flow or circulation of the solution through the baths should be very gentle, because it is undesirable to have any such agitation in the baths as will interfere with the proper deposit upon the bottom of the baths of the foreign matters in the plates to be treated when such foreign matters shall have been separated and dropped upon the bottom of the baths. When the circulation of the liquid is downward through the baths, it may be less apt to disturb the foreign matter deposited upon the bottom of the baths than if the circulation were in some other direction. It will be seen that the baths have combined with them siphons Q, whose shorter arms or limbs are within the baths and extend close to the bottoms of the baths, yet not so close as to reach the foreign matter deposited therein.

The longer limbs of the siphons Q extend outside the baths and down into a trough, N, which is located beneath the baths. The solution passing off through the siphons will therefore be delivered into the trough N. The siphons do not, as here represented, pass over the walls of the baths, but pass through the same near their upper ends. Each of the siphons is provided with a hole, *q*, in the upper part of that one of its limbs which is within the bath with which it is used. Whenever the solution rises in a bath sufficiently high to cover the hole *q* of the siphon which is combined with that bath, then the siphon will be rendered operative as a siphon, and will thereafter continue to siphon out the solution from the lower part of the bath until the solution is lowered below the hole. After this the solution may still flow through the siphon so long as its level remains above the lower portion of the interior surface of the horizontal portion of the siphon. During the last-described flow the operation of the siphon will be that of an overflow-pipe.

By employing siphon-pipes for carrying off the solution I am enabled to remove the solution from the lower part of the baths without appreciably agitating the solution therein. Other outlets for the solution, however, may, if preferred, be used instead of the siphon-pipes.

The electric current passing through the baths will decompose the solution, the anode-plate and the plates G of the metal to be treated will be attacked, so that their sides which are the nearer to the cathode-plates of the baths will be reduced, and the pure copper (assuming the anodes and the plates G to be made of copper combined with other metals) will be deposited on the sides of the plates G which are the nearer to the anode-plates,

and also upon the corresponding sides of the cathode-plates. This action is illustrated in Fig. 4, where the bold lines indicate the original condition of these plates and the dotted lines show their ultimate condition. The precious metals and other foreign matter will fall to the bottom of the baths, and may be taken therefrom as occasion may require. The deposited copper may be easily separated from such portion of the original plates as may remain unchanged.

Precious metals may be separated in the manner described, not only from copper, but also from lead and other metals.

The solution being naturally a little more dense at the bottom through electrolytic action, the operation of drawing from the bottom and returning the heavier solution at the top tends to equalize the density throughout. This is an important item in the process.

The separation of precious metals from base metals is not the only purpose of my process, for it is equally applicable to the separation from metals generally of foreign matters which may be incorporated with them.

I am aware that Letters Patent have been granted covering certain ideas in relation to depositing copper or analogous metal by arranging anode and cathode plates in an electrolytic bath as far apart as possible and interposing between such plates one or more additional plates intended to be refined or to have the constituents separated, and leaving such interposed plates unconnected with the electric circuit employed, except by means of the solution forming the electrolytic bath. In the Letters Patent to which I now refer the plates to be treated are supported by allowing their entire bottom edges to rest upon bars extending transversely across the bottom of the bath. Thus compartments are formed in the bath by the plates in conjunction with their supports. When a current of electricity is passed through such a bath, copper is expected to be taken from the anode sides of the plates and deposited upon the cathode sides of confronting plates, the impurities set free being intended to fall to the bottom of the bath between the plates and their supporting-bars. Means are in this case also employed for agitating the solution in the compartments formed by the plates and their supporting-bars, the object of the agitation being to cause the solution to have a washing action upon the plates.

The agitation of the solution in the compartments is detrimental, for the reason that it keeps the impurities in a state of suspension in the solution and they will be mechanically deposited to a greater or less extent upon the cathode sides of the plates and caused to adhere thereby, the pure copper electrically deposited thus again becoming incorporated with the plates and rendering them impure. It is also a great objection where the impure copper being treated contains precious metals, because particles of such metals being held in suspension in the solution will be lodged upon the cathode sides of the plates and again become incorporated with the plates, and thereby lost, whereas they should fall directly to the bottom of the bath in order that they may be saved. When impurities become thus incorporated with the cathode sides of the plates, they rapidly form spurs or knobs, which are apt in time to become long enough to extend across the intervening space between two plates, causing contact between the plates and precluding the possibility of further treatment between such plates. Such foreign matter or sediment as collects at the bottom of the compartments and on the tops of the transverse bars will also in time have a tendency to cause spurs or knobs to run out from the bottom edges of the plates, and these are apt to terminate the intended treatment. A very serious objection to the arrangement set forth in the Letters Patent under consideration consists in the fact that by causing the plates to rest upon transverse bars arranged upon and extending across the bottom of the bath almost no circulation of solution is possible between the several compartments in the bath, and the solution cannot well be kept at an even density throughout the bath, a consideration which is of the greatest importance in securing a uniform and proper working of the electrolytic operation throughout the entire bath.

By supporting the plates in the bath in the manner which I have illustrated and described as a feature of my improvement a circulation of the solution beneath them is provided for and the formation of spurs, due to the collection of sediment immediately adjacent to the bottom edges of the plates, will be practically avoided, because when those portions of the plates which are subjected to the electrolytic action of the baths are isolated above the bottom of the baths it will take a considerable time for sediment to accumulate upon the bottom of the baths to such an extent as to reach the plates, and such time will be longer than the time required for the electrolytic action. It is obvious that the formation of spurs and the collection of sediment, including metal, would seriously impair the electrolytic action of the baths. Moreover, when the plates are supported in the manner I have illustrated and described, they may be arranged closer together than when arranged and supported in the manner shown in the referred to Letters Patent. Reduction of the resistance offered by the electrolytic solution will result from lessening the space between the plates.

Gentle circulation of the solution which I provide for is advantageous, in that it tends to maintain the solution in a practically homogeneous condition, and yet is insufficient to interfere with either the electrolytic action or the proper deposit upon the bottom of the baths of the foreign matter separated from the plates treated.

The advantages of that step of the treatment which forms the subject of my improve-

ment, and which consists in the rolling of the plates, are numerous and important. The rolling of the plates produces a greater homogeneity of the metal than it would be possible to attain by casting plates. The tendency to the formation of spurs or knobs during electrolytic action is reduced in proportion to the homogeneity of the plates. Plates rolled and thereby condensed, compacted, and rendered practically homogeneous can be used of less thickness than if the plates were merely cast. Indeed, metal plates formed solely by casting would be so porous that if made thin they would soon become disintegrated or segregated into numerous small parts when subjected to electrolytic action, whereas the rolled plates may be subjected to electrolytic action and that action may be continued until the plates have been reduced, as desired. The plates may be rolled to about one-eighth of an inch in thickness, which is thinner than plates can be practically cast. Moreover, when metal is deposited upon one side of the plates, as in my process, the smoothness of surface which is attained by rolling the plates is of advantage, because it admits of making a smoother layer of the deposited metal.

Owing to the smoothness of the surfaces of the plates, the thinness of the plates, and the consequent short period that the plates have to remain in treatment I am enabled to use a more dense current, thereby increasing the rapidity of the deposit.

It is of great importance in other ways to be able to use thin plates. Very many more of such plates may be used in a bath than would be possible if thick plates were employed. The weight of metal under treatment is much less and the length of time necessary for the treatment of the plates reduced. These advantages make it possible to work a very much larger plant with the same capital than would be possible if heavy cast plates were used. The lessened time during which the plates undergo treatment enables capital to be oftener turned, and also reduces the liability to the formation of spurs or knobs extending over to confronting plates. Thin plates may also be handled much more easily than the other plates. Especially is this true when the said plates are made in sections arranged one above another to form a compound plate, as suggested.

By the use of thin rolled plates, which are practically homogeneous, the resistance to the passage of the electric current offered by the solution between the plates may be reduced, because the plates may be arranged so that they will be closer together at all times during the electrolytic treatment. The distance may be reduced even beyond that reduction which is attributable to the method of supporting the plates which I have shown and described. By reducing the resistance an economy of power is obviously effected.

Besides the Letters Patent which I have already referred to, I am aware of Letters Patent of the United States showing an apparatus wherein a solution has been circulated through an electrolytic bath. I am also aware that it is not new to heat the solution of an electrolytic bath.

It will have been seen that the entire treatment which I have described involves a process of treating plates of metal beginning with the rolling of the plates and including the electrolytic separation of the plates into their component parts. Of this treatment the electrolytic operation is but a step. I desire to protect all the novel features and steps of this treatment.

I do not wish to make any claim herein for any peculiar features in the construction of the baths or their appurtenances; nor do I wish to claim herein the particular combinations of mechanisms for conveying the electrolytic solution from a reservoir to the baths and conducting it from the baths back to the reservoir. All these features of my invention I reserve for a future application.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The process of treating metals, consisting in rolling plates of the metal to be treated, arranging such plates in an electrolytic bath between an anode-plate and a cathode-plate without any connection between said plates which are to be treated, or between any of them and the anode or cathode plate, except through the electrolytic solution, and subjecting the plates to the action of a current of electricity, substantially as specified.

2. The process of separating from copper and like metals foreign matter which may be incorporated with the same, consisting in arranging in an electrolytic bath an anode-plate and a cathode-plate at a considerable distance apart, interposing between them one or more plates of the metal to be treated, leaving such plates unconnected electrically, except through the solution of the bath, supporting such plates above the bottom of the bath, so that the lower edge of the portions subject to electrolytic action will have nothing immediately below them, and subjecting the plates to the action of a current of electricity, substantially as specified.

3. The process of separating from copper and like metals foreign matter which may be incorporated with them, consisting in arranging in an electrolytic bath an anode-plate and a cathode-plate, interposing between the latter one or more of the plates to be treated, leaving the same electrically unconnected, save through the solution, in gently circulating the solution from the upper to the lower portion of the bath, and in subjecting the plates to the action of a current of electricity, substantially as specified.

EDWARD S. HAYDEN.

Witnesses:
EDWIN H. BROWN,
D. H. DRISCOLL.